Measurement and Characterization of Gelbstoff Optical Properties as a Water Mass Tracer in Coastal Regions

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LONG-TERM GOAL

To use the optical properties of dissolved organic matter as a tracer of physical mixing processes.

OBJECTIVES

To assess the effects of biological, physical and chemical processes on CDOM concentrations and optical properties in coastal areas and determine over what temporal and spatial scales these optical properties are conservative. To use optical properties of CDOM to identify component species of DOM in situ in coastal regions.

APPROACH

Over 200 continuous profiles and 100 casts for discrete water samples were collected during the Fall 1996 and Spring 1997 field experiments at the Coastal Mixing & Optics site in the North Atlantic Ocean. Gelbstoff concentration and spectral properties were measured as a function of hydrography and turbulent mixing using three different *in situ* instruments. A Sea Tech DOM fluorometer (Ex/Em @ 320/420 nm, 40 nm b.p.) was used to collect profiles on the CTD package. A WetLabs SAFire (Spectral Absorption and Fluorescence Instrument) was deployed on the CTD-rosette frame integrated with 3 AC-9s and an FSI CTD via a WetLabs superMODAPS (Roesler). A WetLabs GPF (General Purpose Fluorometer) configured to measure gelbstoff fluorescence (Ex/Em @ 265/420) was used in the ship's underway seawater system. Discrete samples were collected using the rosette and excitation-emission matrix (EEM) spectroscopy was performed using a SPEX Fluorolog II. Absorption scans were made on discrete samples using a Hitachi U3300 spectrophotometer with 10 cm cells.

RESULTS

Data from the two *in situ* instruments gave similar results for concentration and vertical structure. CDOM concentrations ranged from 0.5 - 2.0 ppb quinine sulfate equivalents (QSE), with small but discernible seasonal and spatial differences. Highest concentrations were observed in the bottom water layer, where CDOM varied positively with salinity during both seasons.

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Depth profiles of a_{CDOM}, F_{CDOM} and pigment fluorescence (F_p), collected using the multi-channel SAFIre, are shown in Figure 1 for a station sampled during the Summer 1996 cruise. CDOM is detected by several of the absorption and fluorescence channels of the SAFIre, simultaneously with phytoplankton pigments. The surface layer present between 0 and 10 m was high in both pigments and CDOM, and CDOM was slightly elevated near the bottom. Differences in profiles are indicative of differences in spectral properties of CDOM and pigments with depth. The profile of fluorescence at Ex/Em 265/350 nm is most likely due to particle scattering, which would explain the high values near the bottom of the water column and also at 5 m.

Three unique types of CDOM were observed at the study site, as determined by fluorescence fingerprints. The EEM from Cast 11 has the concave up shape which is consistent with photobleaching as the dominant process in this sample. It was collected at time when there was a very shallow, warm surface layer with low chl a concentrations and a two-layer CDOM profile (Fig. 2). This photobleached EEM was prevalent in surface waters throughout the Spring cruise period.

A three-layer CDOM profile was observed during Cast 37, with minimum CDOM concentrations at mid-depths (Fig. 3). This appears to have been caused by advection of low salinity, warm water below surface layer. The EEM for the 0 m sample had characteristics of new gelbstoff (Coble, 1996; Coble et al., 1997), including a small chl a peak at 435/680 nm. This is consistent with the high chl a fluorescence observed in the surface layer and is interpreted as evidence of new production of marine CDOM.

Some of the lowest surface salinities observed during the Spring cruise were sampled in the cast 83 profile. Low salinity was coincident with high CDOM and slightly warmer temperatures (Fig. 4), suggesting that the source of the water mass may have been advection of coastal water containing riverine CDOM. This is supported by the EEM for this sample which shows riverine characteristics(Coble, 1996). In contrast to the EEM for Cast 11 (Fig. 2), the Cast 83 sample has convex emission spectra at all excitation wavelengths.

IMPACT

In situ multipsectral in situ measurements of fluorescence, absorption, and scatter at wavelengths below 400 nm are novel and will provide new data relating to organic matter in the ocean. The density of our profiles and the completeness of data provided by collaborators will allow optical characteristics of dissolved organic matter to be interpreted as the direct result of physical and biological processes.

RELATED PROJECTS

Two related projects in collaboration with NRL's Spectral Signatures Program will extend multispectral time series observations to the Chesapeake Bay and the Gulf of Mexico.

REFERENCES

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Conmy, R.N., and P.G. Coble. 1997. Concentrations and optical properties of CDOM during the 1996-97 Coastal Mixing and Optics experiment. 1998 Ocean Sciences Meeting. (manuscript in preparation)

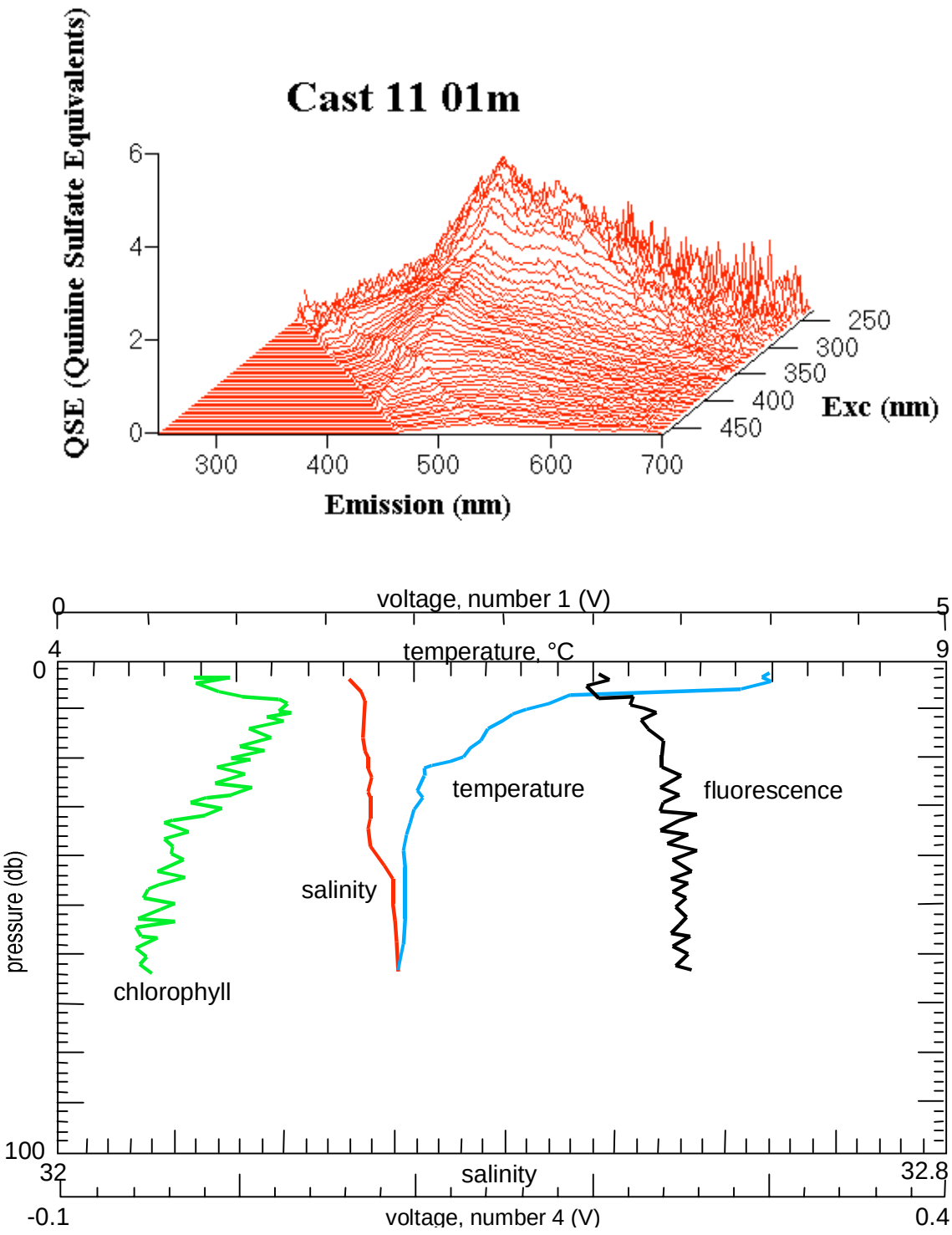

Figure 1. In situ depth profiles of absorption (left), fluorescence at Ex = 265 nm (center), and Ex = 430 nm (right) collected using SAFIre during ONR Coastal Mixing and Optics Summer 1996 cruise. Study site was located at 40.5°N, 70.5°W.

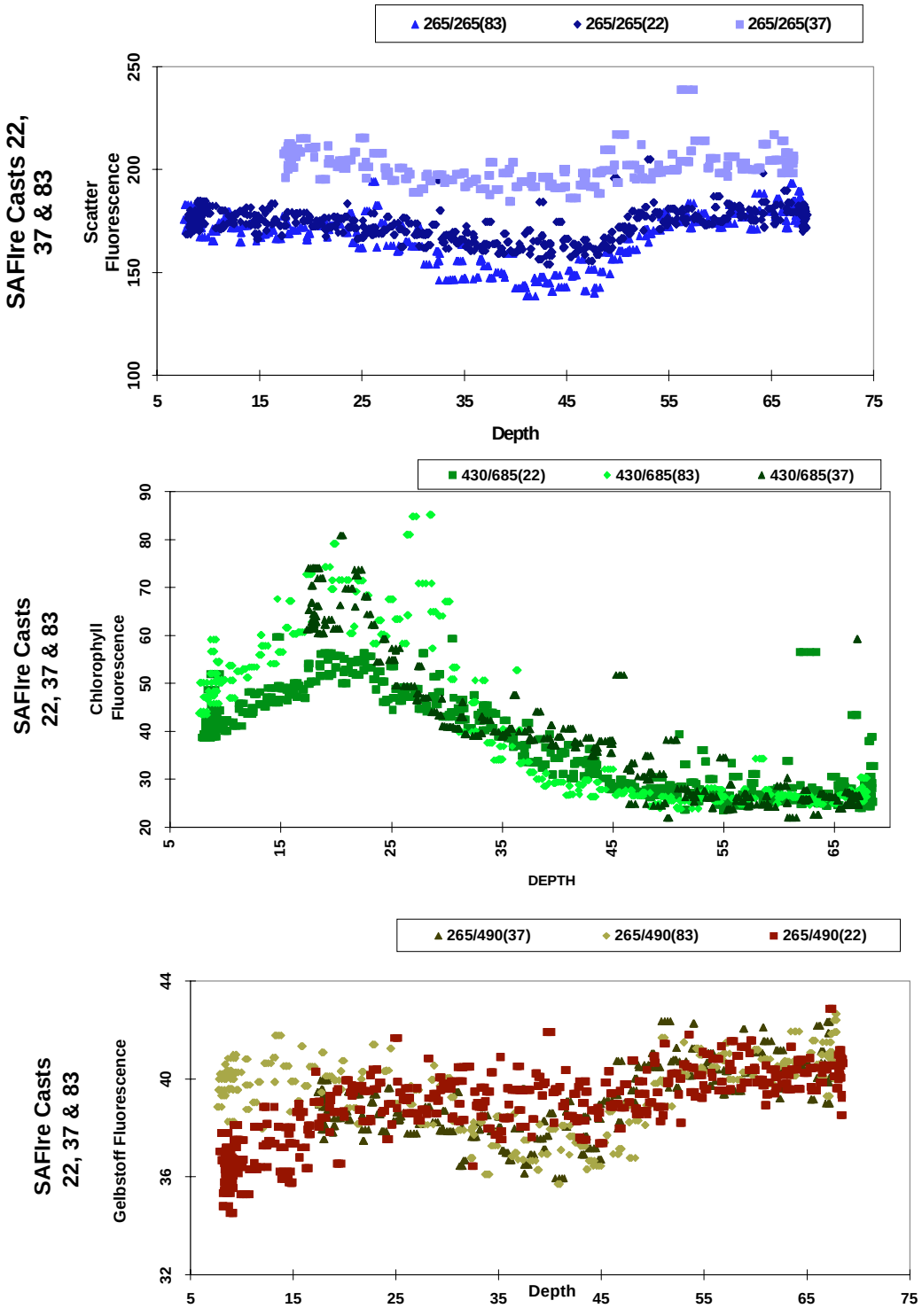

Figure 2. EEM fingerprint and profiles of temperature, salinity, chlorophyll and fluorescence for cast 11 from the spring cruise showing a warm, shallow surface layer low in chlorophyll a and low FDOM. EEM fingerprint is indicative of photobleaching of the CDOM in the surface layer.

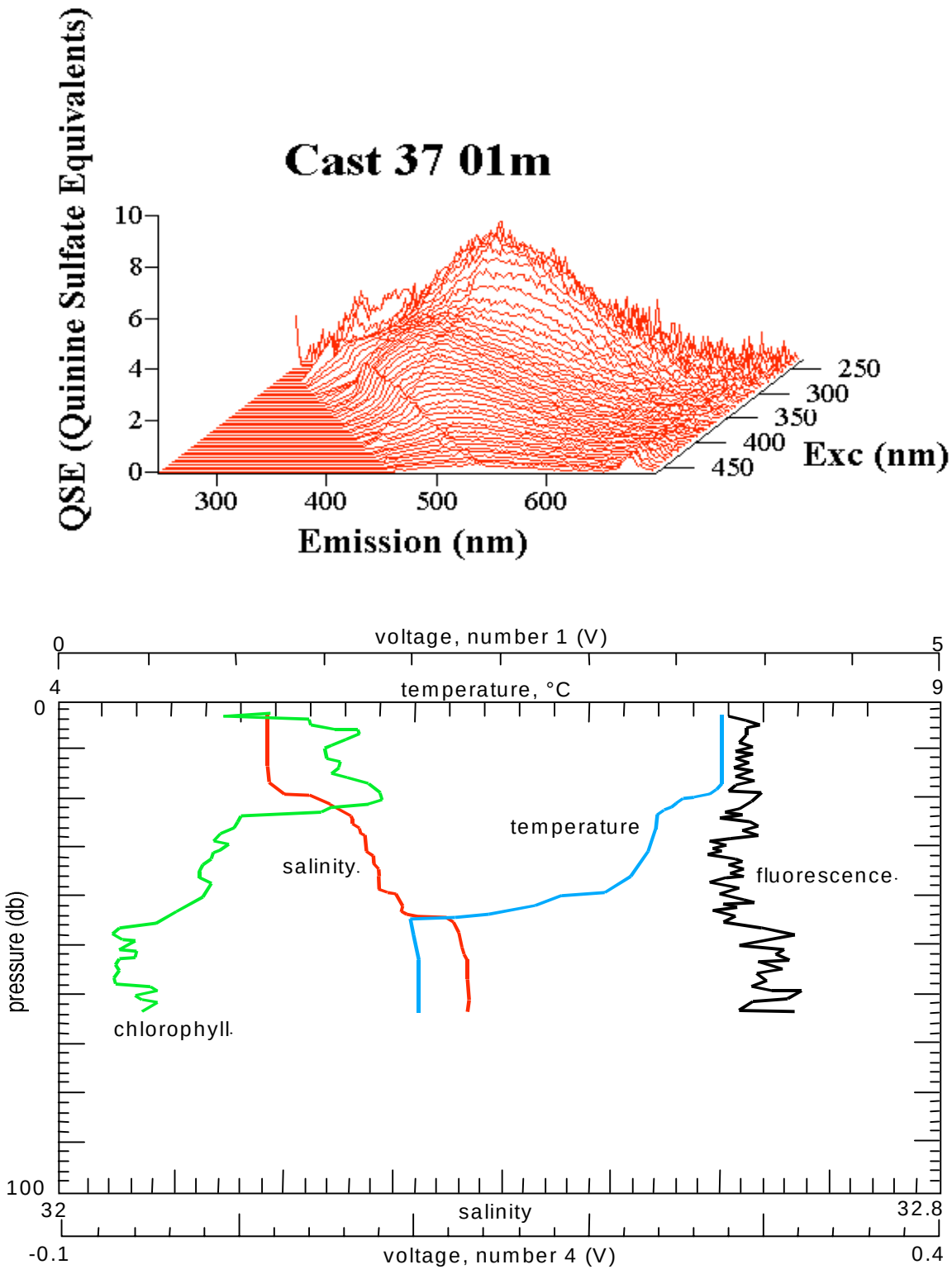

Figure 3. EEM fingerprint and profiles of temperature, salinity, chlorophyll and fluorescence for cast 37 showing a well-mixed surface layer, high chlorophyll a, and FDOM characteristic of new production

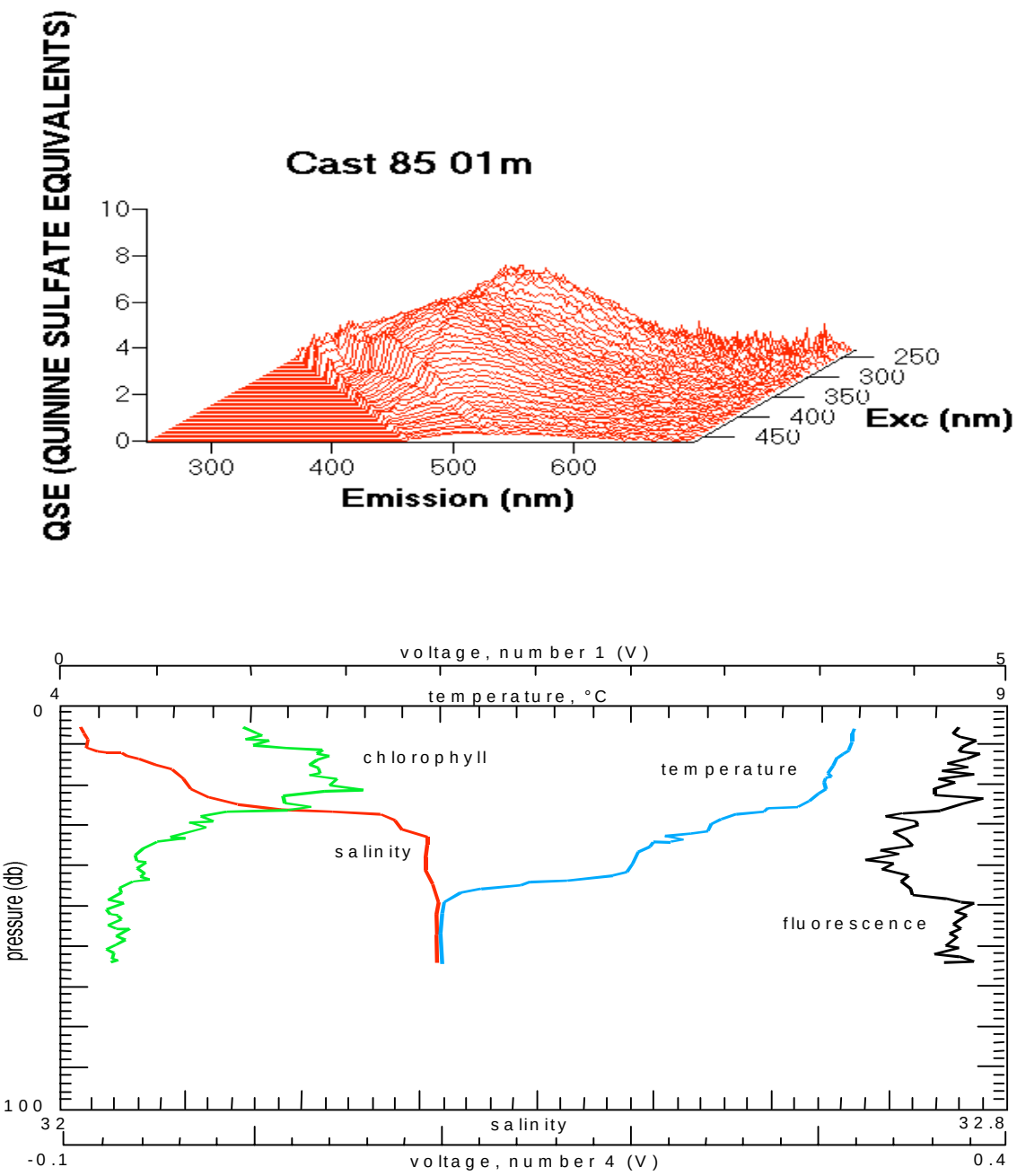

Figure 4. EEM fingerprint and profiles of temperature, salinity, chlorophyll and fluorescence for cast 83 from the Spring cruise showing warm, fresh surface layer with high FDOM, indicative of riverine input of CDOM.